Original Article

Study of Cerebral Hemispheric Lateralization in Stroke and the Arterial Territories Involved in High-risk Patients

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Abstract

Introduction: According to WHO, Stroke is the 2nd leading cause of death and disability after Ischemic heart disease. Prevalence rate of stroke in India varies from 44.45 to 150 per lakh population. Studies have reported a higher frequency of stroke of the left hemisphere. The artery reported to be the most affected is Left Middle Cerebral artery(MCA) followed by Right Middle Cerebral artery. The aim of this study is to determine the side of cerebral hemisphere most affected by stroke and the arterial territories involved in high-risk patients aged above 35 years presenting to the tertiary healthcare centre, as well as to study the sex predilection of stroke. **Materials and Methods:** A cross-sectional prospective study of 50 high risk stroke patients with Diabetes Mellitus(DM) and /or Hypertension(HTN) presenting to General medicine OPD of a tertiary healthcare centre were investigated with CT/MRI for the side of the cerebral hemisphere affected and the arterial territories involved. The data was tabulated over the course of three months and statistical analysis was carried out. **Results:** The left cerebral hemisphere was affected in 50%, right in 40% and bilateral involvement was found in 10% patients. Slight predilection of stroke towards the left was seen, however it was not found to be statistically significant (*P*-value= 0.249). MCA territory was involved in 66% of the patients, Posterior Cerebral Artery(PCA) territory in 8%, Vertebrobasilar Artery(VB) territory in 8%, Anterior Cerebral Artery(ACA) territory in 6% and MCA+ACA in 4%, MCA+VB in 2% and MCA-PCA watershed in 6% patients. **Conclusions:** We found a slight predilection of stroke towards the left, which was however, not found to be statistically significant.We also found that Middle Cerebral Artery(MCA) territory is the most commonly involved in stroke.

Keywords: Anterior cerebral artery (ACA), Laterality, Middle cerebral artery (MCA), Posterior cerebral artery (PCA), stroke, Vertebrobasilar arteries (VB)

Introduction

According to the WHO, stroke is the leading cause of death and disability after ischemic heart disease. The prevalence rate of stroke in India varies from 44.45 to 150 per lakh population (both rural and urban).[1] In studies on carotid artery intima–media thickness and stroke, researchers implicitly assume that cerebrovascular abnormalities show a symmetrical distribution.[2] In a population-based study to evaluate the frequency of stroke, it was found that left-sided ischemic strokes are more common and easily recognized than right-sided strokes.[3] Most of the left middle cerebral artery (MCA) infarctions may be associated with more frequent atherosclerosis in the left carotid artery, lateralization of cortical functions, or both.[4] The consequences of cerebral infarcts involving the left hemisphere differ from those of the right homolog areas.[5]

Submitted: 28-Feb-2024 **Revised:** 24-Mar-2024
Accepted: 28-Mar-2024 **Published:** 29-Apr-2024

Access this article online

Quick Response Code:

Website: www.actamedicainternational.com

DOI: 10.4103/amit.amit_27_24

Objective

1. To determine the side of the cerebral hemisphere most affected by stroke and to determine the arterial territories involved in high-risk patients aged above 35 years presenting with a history of stroke to the tertiary health-care center
2. To study the sex predilection of stroke.

Materials and Methods

Study design

Cross-sectional prospective study.

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How to cite this article: Prerana B, Nivargi S, Jayanthi V. Study of cerebral hemispheric lateralization in stroke and the arterial territories involved in high-risk patients. Acta Med Int 2024;11:56-9.

Study area
Tertiary health-care center.

Sample type
Purposive non-probability sampling.

IRB approval letter
SIMS and RC/EC/05/2023-24.

Study population
Fifty high-risk patients, both male and female aged above 35 years with a history of hypertension (HTN) and/or diabetes mellitus (DM) presenting to the department of general medicine in a tertiary health-care center with the first episode of stroke (ischemic and/or hemorrhagic), who were referred to the department of radiology for investigations of computed tomography (CT) and/or magnetic resonance imaging (MRI), were considered for study after obtaining their informed consent.

The guidelines laid down in the Declaration of Helsinki were followed.

Inclusion criteria
- Patients with a history of HTN and/or DM (both male and female)
- Patients with the first episode of stroke.

Exclusion criteria
- Patients with episodes of recurrent stroke
- Patients not willing to participate in the study.

Observations
The side of the cerebral hemisphere involved along with the arterial territory in patients who presented with the first episode of stroke was noted with their CT and/or MRI reports. CT and/or MRI scans were done using 16 slice CT scanner and 1.5 Tesla MRI scanner, respectively. Arterial territories of the anterior cerebral artery (ACA), MCA, posterior cerebral artery (PCA), and vertebrobasilar (VB) arteries were observed and the involved arterial territory in these patients were noted and data was tabulated over the course of the study.

Statistical analysis
Statistical methods used
Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on mean ± standard deviation (minimum–maximum) and results on categorical measurements are presented in number (%). Significance is assessed at a 5% level of significance.

The following assumptions on data were made
1. Dependent variables should be normally distributed
2. Samples drawn from the population should be random
3. Cases of the samples should be independent.

Chi-square/ Fisher Exact test has been used to find the significance of study parameters.

Significant figures

*Suggestive significance (P value: $0.05 < P < 0.10$).

*Moderately significant (P value: $0.01 < P \leq 0.05$).

**Strongly significant (P value: $P \leq 0.01$).

Statistical software
The statistical software, namely namely SPSS 22.0 (IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY, IBM Corp.) and R environment version 3.2.2 was used for the analysis of the data and Microsoft Word and Excel were used to generate graphs, tables, etc.

Results
In our study, the MRI/CT scan reports of 50 patients with HTN and/or DM who presented with an episode of stroke were analyzed for cerebral hemispheric lateralization and the arterial territories involved. About 72% of the study population were male patients and 28% were female patients [Table 1]. The mean age was 60.12 ± 12.91 years [Table 2]. Among these 52% of patients had HTN and 10% had DM, whereas 38% had both HTN and DM [Table 3]. Fifty-four percent of patients were diagnosed with the help of CT scan and 46% with MRI. It was found that the left cerebral hemisphere was affected in 50% of patients and the right cerebral hemisphere was affected in 40% of patients. Bilateral hemispheric involvement was found in 10% of patients [Table 4]. A slight predilection of stroke toward the left side over the right side was seen, but this was not found to be statistically significant ($P = 0.249$). It was also found that the MCA territory was involved in 66% of the patients, PCA territory in 8%, VB territory in 8%, ACA

Table 1: Gender - frequency distribution of patients studied

Gender	Number of patients (%)
Female	14 (28.0)
Male	36 (72.0)
Total	50 (100.0)

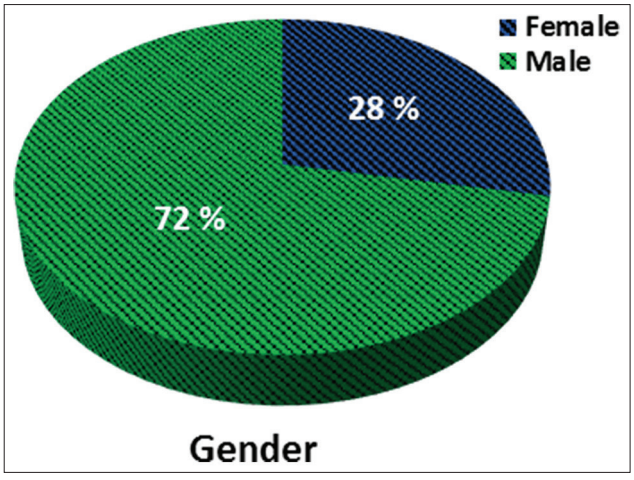


Table 2: Age in years - frequency distribution of patients studied

Age (years)	Number of patients (%)
<50	13 (26.0)
50–60	13 (26.0)
61–70	15 (30.0)
>70	9 (18.0)
Total	50 (100.0)
Mean±SD	60.12±12.91

SD: Standard deviation

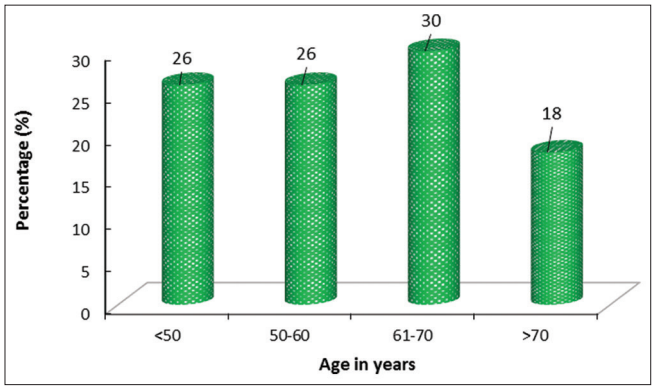
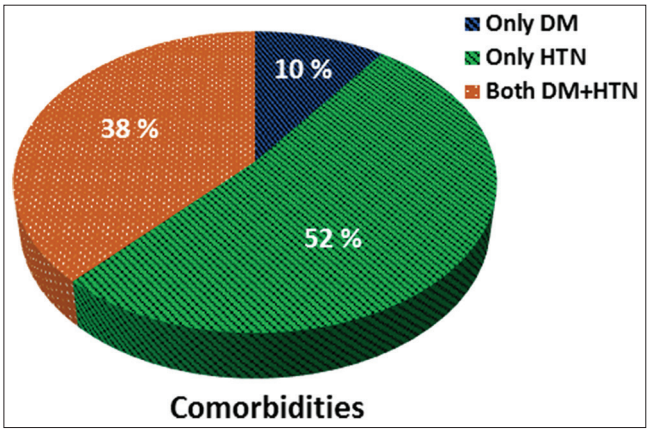


Table 3: Comorbidities - frequency distribution of patients studied

Comorbidities	Number of patients (%)
Only DM	5 (10.0)
Only HTN	26 (52.0)
Both DM + HTN	19 (38.0)
Total	50 (100.0)

DM: Diabetes mellitus, HTN: Hypertension



territory in 6%, MCA + ACA in 4%, MCA + VB in 2%, and MCA-PCA watershed in 6% patients [Table 5].

Discussion

Stroke is the second- leading cause of death mainly in developing countries. The incidence rate varied from 33 to 123/100000 in the urban population and in the rural population

Table 4: Laterality - frequency distribution of patients studied

Laterality	Gender		Total, *n* (%)
	Female, *n* (%)	Male, *n* (%)	
Bilateral	2 (14.3)	3 (8.3)	5 (10)
Left	9 (64.3)	16 (44.4)	25 (50)
Right	3 (21.4)	17 (47.2)	20 (40)
Total	14 (100)	36 (100)	50 (100)

P=0.249, not significant, Fisher's exact test

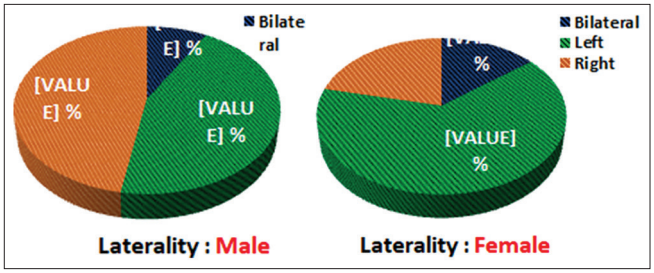
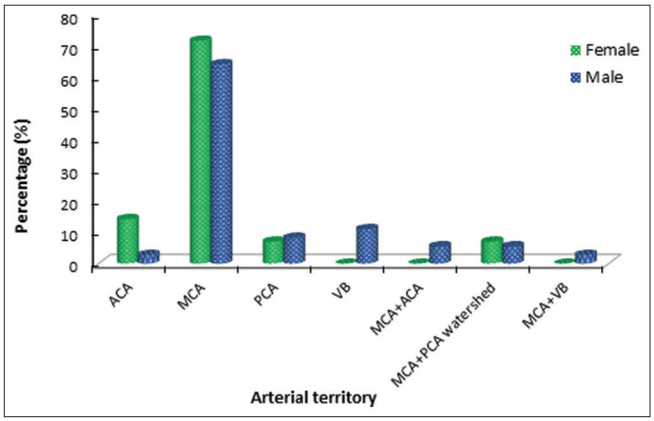


Table 5: Arterial territory - frequency distribution of patients studied

Arterial territory	Gender		Total, *n* (%)	*P*
	Female, *n* (%)	Male, *n* (%)		
ACA	2 (14.3)	1 (2.8)	3 (6)	0.185
MCA	10 (71.4)	23 (63.9)	33 (66)	0.745
PCA	1 (7.1)	3 (8.3)	4 (8)	1.000
VB	0	4 (11.1)	4 (8)	0.317
MCA + ACA	0	2 (5.6)	2 (4.0)	1.000
MCA-PCA watershed	1 (7.1)	2 (5.6)	3 (6.0)	1.000
MCA + VB	0	1 (2.8)	1 (2.0)	1.000
Total	14 (100)	36 (100)	50 (100)	-

Chi-square test/Fisher's exact test. ACA: Anterior cerebral artery, MCA: Middle cerebral artery, PCA: Posterior cerebral artery, Vb: vertebrobasilar arteries



it was estimated to be 123.57/100000.[1] Hospital-based retrospective studies have reported a higher frequency of stroke of the left hemisphere than of the right hemisphere and the reason for the same has been attributed to certain factors related to the specific anatomy of the carotid vessels or they are simply

recognized more easily by clinicians.[2,3] In our study, a slight predilection of stroke involving the left cerebral hemisphere over the right was seen. A study reported that the artery found to be affected the most is the left MCA, with the right MCA in the second place.[4] The findings in our study are consistent with this. The outcome of stroke of the right hemisphere is known to be less favorable with a higher fatality rate.[5] Individuals with right-sided stroke are reported to have reduced endothelial function and arterial compliance compared to those with left-sided stroke, indicating that right-sided strokes are more susceptible to cardiovascular events.[6] Right hemisphere involvement showed a higher rate of atrial fibrillation and higher proportion of cardioembolism than the left. Right hemisphere involvement was independently associated with an increased risk of malignant brain edema and composite of cardiovascular events during hospitalization.[7] Different geometrical patterns of aortic arch branching seem to affect the laterality of cardioemboli and increase its left side predilection of stroke.[8] Multiple risk factors such as age, gender, lifestyle, stroke type, medication, lesion location and comorbidities are related to poststroke neuropsychiatric complications as well.[9] One study reported that the overall prevalence of stroke is higher in men than in women and increases with age in both sexes.[10] In our study, we found that among those affected, 72% were men and 28% were women. The mean age of patients in our study was 60.12 ± 12.91 years. This finding is consistent with the study conducted in North Odisha where incidence was maximum in the age group of 51–70 years with a mean age of 61.4 ± 13.1 years.[11] Any cerebrovascular accident on the left side is easily recognized due to noticeable symptoms in the majority of the population and is perceived as more severe. However, right-sided strokes tend to be neglected or recognized much later. Therefore, it is important to spread awareness about right-sided stroke and its rather discrete symptoms for early recognition and management.

Consequently, more attention needs to be paid for symptoms and signs of right-sided strokes by clinicians as these are known to be less favorable with higher fatality rates.

Conclusions

In our study, we found that the MCA territory is the most commonly affected arterial territory in both males and females. The incidence of stroke was found to be more in males than females. We also found a slight predilection of stroke towards the left side over the right. However, this was not found to be statistically significant.

Limitations of the study

Certainly, several limitations apply to the present study. The sample size considered here may not be sufficient to obtain significant data. The classification of cases into ischemic or hemorrhagic strokes was not considered. Both lacunar and nonlacunar strokes were considered during analysis for side predilection. The outcomes of stroke on either side were not assessed.

Hence, there is scope for future work considering this as a pilot study.

Financial support and sponsorship

This study was funded by Rajiv Gandhi University of Health Sciences under Short Term Research Grants.

Conflicts of interest

There are no conflicts of interest.

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